

REMARKS

Claims 49-77 and 132 are pending in this application. Claim 49 has been amended. New claim 132 has been added to round out the scope of protection afforded the claimed invention. No new matter has been introduced.

Claims 49-56, 59-62, 72-74, 76 and 77 stand rejected under 5 U.S.C. § 103(a) as being unpatentable over Matsumoto (EU 0360595) ("Matsumoto"). This rejection is respectfully traversed.

The claimed invention relates to a method of forming a photodiode with an ultra-shallow junction. The ultra-shallow junction is provided by forming an ultra-shallow pinned surface layer which has a thickness of about 100 Angstroms to about 500 Angstroms and which facilitates blue light absorption and reduced leakage. As described in paragraphs [0012] and [0013] of the application, photons of blue light do not travel very deep into the silicon. The invention provides a photosensor which is better adapted for photon to charge conversion for blue wavelengths while reducing surface effect leakage.

Amended independent claim 49 recites a "method of forming a photodiode for a pixel sensor cell" by *inter alia* "forming a gate of a transistor over a substrate" and "forming a first doped layer of a first conductivity type in said substrate and adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms to facilitate blue light absorption." Amended independent claim 49 also recites "forming a doped region of a second conductivity type in said substrate and below said first doped layer."

Matsumoto relates to a solid state imager. According to Matsumoto, "in the principal surface portion of an impurity region of first conductive type composing a PN

junction photo diode, an impurity region of reverse conductive type is formed in the almost entire region except for a part of side area of an electric charge reading part.” (Abstract). Matsumoto also teaches that “[w]hen the impurity region of reverse conductive type is formed in the principal surface portion of the impurity region of one conductive type, the interface trap level generated in the interface of the semiconductor substrate and silicon dioxide film on its surface can be reduced, so that the generation of dark current may be significantly decreased.” (Abstract).

The subject matter of claims 49-56, 59-62, 72-74, 76 and 77 would not have been obvious over Matsumoto. Specifically, the Office Action fails to establish a *prima facie* case of obviousness. Courts have generally recognized that a showing of a *prima facie* case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. See e.g., In re Dembiczak, 175 F.3d 994 (Fed. Cir. 1999); In re Rouffet, 149 F.3d 1350, 1355 (Fed. Cir. 1998); Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996).

In the present case, Matsumoto fails to disclose, teach or suggest all limitations of amended independent claim 49. Matsumoto does not disclose, teach or suggest “forming a first doped layer of a first conductivity type in said substrate and adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms to facilitate blue light absorption,” as independent claim 49 recites. Matsumoto teaches the formation of the P-type region 11 (which would arguably correspond to the “first doped layer” of the claimed invention) in the surface portion of the N-type region 5. (Col. 3, lines 32-45). However, Matsumoto teaches that the P-type region 11 is formed to a thickness of 0.5 μ m (col. 3, line 44),

which is equal to 5,000 Angstroms, and not to “a thickness of about 100 Angstroms to about 500 Angstroms to facilitate blue light absorption,” as in the claimed invention.

Applicants further submit that the specification of the present application clearly discloses the criticality of the dimensions of the ultra-shallow pinned surface layer which has a thickness of about 100 Angstroms to about 500 Angstroms. The specification notes that “it is desirable for p-n junctions, such as the p-n junction between the p-type pinned layer 24 and the n-type region 26 of FIG. 2, to be very shallow” (application at ¶[0013]). The specification teaches that a shallow pinned surface layer is needed “to ensure that the leakage arising due to surface effects (defects, poor passivation, etc) do not contribute to the photodiode response characteristics” (application at ¶[0014]) and “for an improved high blue response photosensor with suppressed transient-enhanced diffusion” (application at ¶[0015]). The specification also notes that “the invention provides a pinned photodiode with an ultra-shallow pinned layer for maximized blue light absorption” (application at ¶[0016]) so that “a very shallow PN junction is formed between the ultra-shallow p-type pinned surface layer 188 and the n-type region 126 which allows for maximized blue response in a photosensor” (application at ¶[0056]). Thus, the ranges for the thickness of the first doped layer (of about 100 Angstroms to about 500 Angstroms) as recited in claims 49, 52 and 53 (and as described in the specification at ¶¶ [0016] and [0017], for example) are critical for attaining maximum blue response and they do not involve routine optimization within the level of ordinary skill in the art.

For at least the reasons above, the Office Action fails to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claims 49-56, 59-62, 72-74, 76 and 77 respectfully requested.

Claims 57, 58, 63 and 64 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Kirkpatrick (U.S. Patent No. 4,151,008) ("Kirkpatrick"). Claims 66, 67 and 71 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd (U.S. Patent No. 6,743,738) ("Todd"). Claim 70 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd and further in view of Fuse (U.S. Patent No. 4,861,729) ("Fuse"). Claims 68 and 69 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd and further in view of Tom (U.S. Patent No. 5,993,766) ("Tom"). These rejections are respectfully traversed.

First, Applicants note that the rejection of claims 57, 58, 63, 64 and 66-71 is predicated on Matsumoto, which fails to disclose, teach or suggest all limitations of claim 49 and of dependent claims 57, 58, 63, 64 and 66-71. Applicants also submit that the additional prior art references have been cited to supplement the deficiencies of Matsumoto with respect to the anneal parameters and boron implantation. None of these references, however, discloses, teaches or suggests a "method of forming a photodiode for a pixel sensor cell" by "forming a gate of a transistor over a substrate" and "forming a first doped layer of a first conductivity type in said substrate and adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms to facilitate blue light absorption," as in the claimed invention.

Second, Applicants submit that a person of ordinary skill in the art would not have been motivated to combine the teachings of Matsumoto with those of Kirkpatrick, Todd, Fuse or Tom, to arrive at the claimed invention. To establish a *prima facie* case of obviousness, "[i]t is insufficient that the prior art disclosed the components of the patented device, either separately or used in other combinations; there must be some teaching, suggestion, or incentive to make the combination made by the

inventor.” Northern Telecom, Inc. v. Datapoint Corp., 908 F.2d 931, 934 (Fed. Cir. 1990). This way, “the inquiry is not whether each element existed in the prior art, but whether the prior art made obvious the invention as a whole for which patentability is claimed.” Hartness Int’l, Inc. v. Simplimatic Engineering Co., 819 F.2d 1100, 1108 (Fed. Cir. 1987). Accordingly, a determination of obviousness “must involve more than indiscriminately combining prior art; a motivation or suggestion to combine must exist.” Pro-Mold & Tool Co., 75 F.3d at 1573.

The February 15, 2006 Office Action fails to establish a *prima facie* case of obviousness because, as the Court in Northern Telecom, Inc. noted, “[i]t is insufficient that the prior art disclosed the components of the patented device” and there is no “teaching, suggestion, or incentive to make the combination.” Northern Telecom, Inc., 908 F.2d at 934. On one hand, the crux of Matsumoto is a PN junction photo diode having an impurity region of reverse conductive type formed in the almost entire region except for a part of side area of an electric charge reading part. On the other hand, Kirkpatrick relates to a pulsed laser or flash lamp that produces a short duration pulse or light for thermal processing and teaches a pulsed light source 12 arranged on a specific platform (Fig. 1), while Todd teaches deposition methods for formation of silicon alloys. Fuse teaches the doping of a sidewall of a capacitor trench by directing impurities to enter directly the sidewall of the capacitor trench, while Tom is directed to a system for the storage and delivery of a sorbable fluid comprising a dispensing vessel having a sorbent material. Thus, it is clear that the only element which Matsumoto and the additionally cited prior art references have in common is the substrate on which their respective structures are formed. A person of ordinary skill in the art would not have been motivated to combine these disparate references and, for at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness. Withdrawal of the rejection of claims 57, 58, 63, 64 and 66-71 is respectfully requested.

New dependent claim 132 has been added to recite that the first doped layer "provides maximum blue light absorption." Applicants submit that none of the cited prior art references discloses, teaches or suggests this claim limitation.

Allowance of all pending claims is solicited.

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Respectfully submitted,

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